PATENT SPECIFICATION

419,835

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PROVISIONAL SPECIFICATION.

Improvements in or relating to Electro-magnetic Apparatus.

I, MAX FLEINER, of Swiss nationality, of Gempenstrasse 5, Basle, Switzerland, do hereby declare the nature of this invention to be as follows:—

The object of the present invention is to provide electro-magnetic apparatus which is adapted to perform two distinct functions simultaneously, and which is relatively cheap to manufacture, as compared with previously known arrangements capable of performing the same duties.

The present invention enables machines to be produced in which certain parts are employed. in common, to perform separate functions or to attain separate objects. It is especially applicable to electric motors which are provided with braking mechanism, one function of the apparatus being the production of mechanical power and another function being the operation of the brake

According to the present invention, in electromagnetic apparatus two or more independently movable members are adapted to be influenced wholly or partly by the same lines of force of a magnetic circuit, the arrangement being such that at least two of the movable members can be caused to operate independently under the influence of the common lines of force in such a manner as to perform at least two separate working functions.

In one construction according to the invention, a movable auxiliary member is accommodated in a gap formed at a suitable place in a magnetic circuit of an electric motor, the arrangement being such that, under the influence of the lines of force in the said magnetic circuit, the auxiliary member is capable of performing useful work, for example, of actuating brake mechanism.

In applying the invention to a continuous-current motor or generator I may proceed as follows. A pole-piece is separated from the yoke of the machine by a discontinuity in the magnetic circuit; the discontinuity may be formed by an air gap or by a member of non-magnetic material by which the pole-piece is secured to the yoke. An iron plunger is slidably fitted in a radial hole formed in the yoke and is adapted to contact with the back of the pole piece. The inner end of the plunger may be conical, and a corresponding conical hole may be formed in the pole piece. The plunger forms an intermediate member in the magnetic circuit including the yoke and the pole piece, and the force which in consequence acts on the plunger enables the plunger to perform a separate function. For example, the plunger, in moving radially inwards as a result of excitation of the field of the machine, may actuate brake mechanism to release a brake on the machine shaft.

With alternating current squirrel-cage motors the separate working function can be obtained as follows. The stator laminations are provided with radial gaps so arranged as to form in the magnetic circuit a discontinuity running the whole length of the stator. This elongated gap accommodates a movable intermediate member which forms a magnetic bridge over the gap. The arrangement is such that, when the stator is energized, the intermediate member is urged radially inwards by the magnetic attraction between this member and the edges of the gap. When the gap between the stator laminations and the auxiliary member is small, the operation of the apparatus as a motor is not affected to any material extent.

The intermediate member may comprise semi-circular laminations, stamped simultaneously with the stator laminations from common blanks, the radially outer edges of the gap corresponding in shape to the intermediate member. This member may be pivotally mounted at one end about an axis transverse to the rotor axis, so that it can rest closely in the gap and be rocked so as to move radially out of the gap.

To prevent the stator casing from acting as a magnetic path in parallel with the gap, the stator laminations may be separated from the casing by non-magnetic distance-pieces. Alternatively the casing may be interrupted at suitable places by longitudinal gaps; and the end members carrying the rotor bearings are prefer-

[*Price* 1/-]

Price 4s 6d

ably of non-magnetic material, or if of magnetic material, they may be attached to the casing by the agency of distance-pieces of non-magnetic material.

It is often desirable that the second working operation should proceed with as uniform a force as possible. However, the force acting on the movable intermediate member varies considerably with displacement of that member, being at its maximum when the intermediate member is nearest to the other iron part or parts of the magnetic circuit with which it co-operates. The movable intermediate member may therefore be connected to the mechanism which it is required to operate, by a toggle linkage, cam mechanism or equivalent means for transforming the varying force into a uniform force.

For example, in the arrangement herein described with reference to an alternating current motor, an extension on the end of the intermediate member remote from the pivot may be provided with a suitable cam surface co-operating with a roller or other cam follower adapted to move longitudinally of the motor. The roller may be journalled on one end of an arm pivotally mounted on the end plate of the motor at a point diametrically opposed to the roller, the arm comprising a hollow boss through which the rotor shaft passes. This shaft carries a brake drum having a conical edge co-operating with a brake pad or annulus fixed to the end plate, and the rotor shaft is urged, for example, by spring means, towards that end plate so that the hub of the brake drum presses against the boss on the lever mounted on the end plate. When the stator is not energized, the rotor is held by the spring in such a position that the brake drum is engaged with the brake pad. Excitation of the stator causes the auxiliary member to be drawn inwards, and the cam moves the roller so as to rock the arm away from the end plate, thereby sliding the rotor against the action of the spring and disengaging the brake.

The invention enables machines to be easily constructed for performing several independent functions. For example, the stator of a motor may be interrupted by two diametrically opposed gaps in each of which is provided an independently movable member. Thus, including the rotor, there are three members capable of performing distinct duties. One of the auxiliary members may consist of a wound rotatable armature of known type which will provide an efficient magnetic bridge. Alternatively, the auxiliary member may have a low or negligible magnetic susceptibility; for example, it may consist essentially of a coil or a copper disc so arranged as to be capable of performing a distinct operation, such as actuating contactors. In such cases it is desirable to make the gap as narrow as possible. An auxiliary member may also comprise a wedge section blade of magnetic material movable radially into and out of a gap of corresponding section in the stator.

The auxiliary movable member may be associated with a delay-action or damping device.

Such a member can conveniently be arranged to operate a low-voltage cut-out.

The invention is applicable not only to stators of dynamo-electric machines, for example it can be applied to rotors of such machines.

Dated this 27th day of July, 1933.
REDDIE & GROSE,
Agents for the Applicant,
6, Bream's Buildings, London, E.C. 4.

COMPLETE SPECIFICATION.

Improvements in or relating to Electro-magnetic Apparatus.

I, MAX FLEINER, of Swiss nationality, of Gempenstrasse 5, Basle, Switzerland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to rotary dynamo-electric machines, and especially to electric motors provided with a brake mechanism.

It has already been proposed to provide, in motors of the salient pole type, either a movable pole, or a movable iron element adapted to serve as a magnetic bridge between the pole and the magnetic yoke, the movable pole or element being adapted, upon excitation of the motor, to perform a working function, independently of the function of the armature of the machine, under the influence of magnetic force.

With such proposed arrangements, either the force acting on the additional movement element would be small, or the cost of production would be high;

furthermore, the proposals were limited to machines having salient poles, from which the lines of force flowed.

The object of the present invention is to provide a machine without salient poles, such for example as an alternating-current motor, having an additional movable element adapted, upon excitation of the machine, to be influenced by a relatively powerful magnetic force so that it is capable of being moved, independently of the rotor. The movable element is especially adapted to operate a brake.

Furthermore, the improvement is easily applicable to various kinds of machines not having salient poles, since it does not require any very considerable alteration in design; it is economical in material and space, and suitable for mass production.

According to the present invention, a dynamo-electric machine having a stator element, a rotor element, and an additional magnetic element movable independently of the rotor element and adapted to operate under the influence of the lines of force in a magnetic circuit traversing said rotor, is characterized in that the stator, which has the form of a closed or substantially closed annular member without salient poles, is interrupted by a zone of high reluctance, such as a gap or a local reduction in cross section, and the movable magnetic element is disposed adjacent to this zone in such a manner that, upon energizing of the machine, the movable element is drawn into contact with the surfaces of the stator adjoining this zone, the movable element being so shaped that it is adapted effectively to bridge the zone.

The invention will be further described with reference to the various constructional examples shown in the accompanying diagrammatic drawings, in which

Fig. 1 is a sectional end elevation of part of an alternating-current squirrel-cage motor, taken on the line 1—1 in Fig. 2, while Fig. 2 is a section on the line 2—2 in Fig. 1,

Fig. 3 is an end elevation of a modification,

Fig. 4 is an end elevation of a part of an alternative arrangement.

Fig. 5 is an end elevation of a different arrangement,

Fig. 6 is an end elevation of a motor having two auxiliary movable magnetic elements,

Fig. 7 is an end elevation of another form of motor, and

Fig. 8 is a sectional side elevation on the line 8—8 in Fig. 7.

Referring to Figs. 1 and 2, the annular stator laminations 1 are provided with a gap 2 which forms a part of high reluctance in the magnetic circuit denoted by the dotted line 3. This gap is bounded, at its outer side, by curved recesses 4 which accommodate a laminated magnetic element 5 which is pivoted to the motor casing 8 about an axis 6 and which forms a magnetic bridge over the gap 2. A spring 7 acting on an extension 5^1 of the element 5 urges this element away from the gap. When the stator 1 is energised, the movable element 5 is drawn radially inwards by the magnetic attraction between this element and the recessed portions 4. When the clearance between the element 5 and the stator is small, the operation of the apparatus as a motor is not affected to a material extent.

To prevent the casing 8 from acting as a magnetic path in parallel with the gap, the stator laminations 1 may be separated from the casing by non-magnetic distance-pieces 9. Alternatively the casing may be interrupted by longitudinal gaps such as 10, and the end members are preferably of non-magnetic material, or, if of magnetic material, are attached to the casing by the agency of distance-pieces of non-magnetic-material.

It is often desirable that the second working operation should proceed with as uniform a force as possible. However, the force acting on the auxiliary movable element varies considerably with displacement of that element, being at its maximum when the element is nearest to the other iron part or parts of the circuit with which it co-operates. The auxiliary movable element may therefore be connected to the mechanism which it is required to operate by a toggle linkage, such as that indicated by the dotted lines 11 in Fig. 2, or equivalent means for transforming the varying force into a uniform force.

For example, in the construction shown in Figs. 1 and 2, an extension 5^{11} of the element 5 is provided with a suitable cam surface 12 co-operating with a roller cam-follower 13 which is journalled on an arm 14 pivotally mounted at 16 on an end member 15 of the casing, the arm comprising a hollow boss 14^1 through which the rotor shaft 17 passes. To this shaft is fixed a brake drum 18 having a conical periphery co-operating with a brake pad 19 fixed to the casing member 15, and the rotor shaft is urged, for example by a spring, not shown, in the direction of the arrow. When the stator is not energized, the rotor is held by the spring in such a position that the brake drum 18 is engaged with the brake pad 19.

Excitation of the stator causes the element 5 to be drawn towards the stator axis, and the cam 12 moves the arm 14 so that its boss 14¹ engages the hub of the brake drum 18, thereby sliding the rotor shaft against the action of the spring and disengaging the brake.

In the modification shown in Fig. 3, instead of a gap, a longitudinal groove 20 is cut in the stator 1*a*, forming a narrow portion 21 which becomes magnetically saturated and thus diverts the lines of force through the adjacent auxiliary bridging element 5*a*, which is movable radially. The lines of force denoted by 3*a*, 3*a*¹, 3*a*¹¹ are those existing at an instant when the stator is excited symmetrically with reference to the movable element 5*a*. Owing to the higher reluctance of the path traversed by the lines 3*a*, the majority of the lines would tend to follow the paths 3*a*¹ and thus the working capacity of the element 5*a* would be weakened. However, to avoid this, the stator laminations are provided with radial slits 22, and the lines of force following the paths 3*a*¹ must pass through places of narrow section. The slits are of such a size that, with normal excitation the magnetic resistance of the whole circuit 3*a*¹ differs little from the value it would have if the slits were absent, but that, upon a slight increase in the number of lines of force, the magnetic resistance rises substantially as a result of magnetic saturation at the places of narrow section. An advantage of this arrangement is that movement of the auxiliary element 5*a* into its radially outer position reduces the total inductive resistance of the motor, so that momentarily an increased current flows, which increases the magnetic force acting on the element 5*a*.

Fig. 4 shows a detail applicable to the arrangements hereinbefore described. In this case the part of high reluctance in the stator is formed by an abnormally deep slot 23. In order to ensure a continued increase in the magnetic resistance across the narrow portion 21 of the stator, two conducting bars 24 and 25, joined by end connections 26, are provided to form a short-circuited winding. The current induced in this winding automatically increases the magnetic resistance of the portion 21 so that the major part of the lines of force traverse the movable bridging element 5*a*. To increase this effect, additional short-circuited windings 27 may be used, which operate similarly.

In the modification shown in Fig. 5 (in which the slits, magnetic paths, and other features are omitted for simplicity) short-circuited windings 28 are provided, which may consist of one or more turns and which serve to increase the magnetic resistance in one or more of the magnetic paths or branches. The windings 28 are preferably arranged to be momentarily in use, that is, until the auxiliary bridging element has completed its movement. This element may be arranged to move a lever 29 which electrically connects the conductors of a winding 28, in the direction of the arrow so as to interrupt the winding.

A further feature is the provision of a magnetic member 30 which is displaceably arranged in a groove 31 in the stator 1*a*, and which may be moved similarly to the lever 29 for the purpose of momentarily increasing or decreasing the magnetic resistance.

Fig. 6 shows a further modification in which two movable bridging elements 5*b* are pivotally mounted about longitudinal axes 6*b*, and diametrically opposed and connected to a common operating element, which is thus capable of exerting a relatively powerful force. The additional movable element acts similarly to one of the radial slits 22 in Fig. 3, as regards its effect on flux distribution. With the four-pole arrangement shown in Fig. 6 when the field has rotated 45 deg. from the position shown, two of the main magnetic circuits will not include the elements 5*b*. To secure the best results therefore, it is preferable to make the number of movable elements equal to the number of poles.

In the arrangement shown in Figs. 7 and 8, the bridging element 5*c* has the form of a wedge fixed to an axially slidable rod 33 and accommodated in a wedge shaped recess, which may constitute a gap, but which is here shown as a groove 20*c* in the stator 1*c*. Between the groove 20*c* and the portion 21*c* of high reluctance of the stator is disposed a plate 35 of non-magnetic material which serves to make the lines of force pass through the tapered sides of the wedge element 5*c*. The plate 35 may be provided with a ridge 35¹ which serves to guide the wedge. Two such wedges are shown in Fig. 7, but one or any desired number may be used. The wedge can operate against a spring 34 abutting against a casing part 32 (which is omitted in Fig. 7) so that, when the motor is de-energized, the rod 33 is moved to the left (Fig. 8). Such an arrangement is particularly suitable for preventing a rotatably mounted "stator" from rotating during the switching-in period. For this purpose the ends of the rods 33 may be forced, under the influence of the magnetic force,

into recesses, and in this manner hold the stator automatically stationary during the starting period.

In order to increase momentarily the force exerted by the auxiliary magnetic element, switching means may be provided which are so arranged as to permit the current flowing in the exciting circuits of the improved machine to be increased and which are operatively connected with the auxiliary element.

The auxiliary member or members may be employed to perform functions other than operating a brake; for instance they may be associated with delay-action devices of known type and arranged to operate a low-voltage cut-out, or a starting rheostat.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A dynamo-electric machine having a stator element, a rotor element, and an additional magnetic element movable independently of said rotor element and adapted to operate under the influence of the lines of force in a magnetic circuit traversing said rotor, characterised in that said stator, which has the form of a closed or substantially closed annular member without salient poles, is interrupted by a zone of high reluctance, and said movable magnetic element is disposed adjacent to said zone in such a manner that upon energizing of the machine the movable element is drawn into contact with the surfaces of the stator adjoining said zone, said element being so shaped that it is adapted effectively to bridge said zone.

2. Apparatus as claimed in claim 1, wherein said zone of high reluctance is formed by a gap in said annular stator member.

3. Apparatus as claimed in claim 1, wherein said zone of high reluctance is formed by locally reducing the cross section of the annular stator member so that the reduced portion is adapted to become magnetically saturated.

4. Apparatus as claimed in claim 2 or 3, wherein said additional movable element is accommodated in a recess extending longitudinally from end to end of said annular stator element.

5. Apparatus as claimed in claim 4 wherein said recess tapers longitudinally of said stator element said additional magnetic element being correspondingly tapered and movable in said longitudinal direction.

6. Apparatus as claimed in claim 5, wherein said recess is in the form of a groove, the movable tapered element being separated from the adjacent portion of the stator element at the bottom of the groove by a spacing member of non-magnetic material.

7. Apparatus as claimed in claim 2 or 3 wherein the additional magnetic element is provided with a plane surface cooperating with a plane surface formed on the stator element, the direction of motion of the additional element being substantially normal to these plane surfaces, and the zone of high reluctance in the stator element being disposed along a line dividing the said plane surface on that element.

8. Apparatus as claimed in any one of the preceding claims, in which a magnetic circuit is branched, the lines in only one branch influencing the movable magnetic element, wherein there are provided in the other branch means which temporarily or permanently increase the magnetic resistance thereof and thereby influence the magnetization of the magnetic element for the purpose hereinbefore set forth.

9. Apparatus as claimed in claim 8, wherein the second-mentioned branch is provided with a narrow portion which serves to limit the number of lines of force passing therethrough, as a result of magnetic saturation.

10. Apparatus as claimed in claim 9, wherein the said narrow portion is formed by the provision of one or more radial slots in the stator element.

11. Apparatus as claimed in claim 10, wherein one of said slots accommodates a displaceable member capable of influencing the magnetic resistance of the branch and operatively connected with the movable magnetic element which is influenced by the lines of force in the first-mentioned branch.

12. Apparatus as claimed in claim 8, wherein the said means are formed by a winding which is adapted to be traversed by an alternating magnetic flux in the branch, and which is short-circuited or adapted to be short-circuited.

13. Apparatus as claimed in claim 12, wherein switching means operable for short-circuiting the said winding are operatively connected with the movable magnetic element which is influenced by the lines of force in the first-mentioned branch.

14. Apparatus as claimed in any one of the preceding claims wherein non-magnetic distance-pieces are provided between the stator element and a casing of magnetic material, for the purpose hereinbefore set forth.

15. Apparatus as claimed in any one of claims 1 to 13, wherein a casing of mag-

netic material which houses the stator is provided with a longitudinal gap, for the purpose hereinbefore set forth.

16. Apparatus as claimed in any one of the preceding claims, wherein one of the movable elements is connected with the mechanism which it is required to operate by means, such as a toggle linkage or a cam, which serves to transform the varying force exerted by the lines of force on the movable element into a substantially constant operating force.

17. Apparatus as claimed in any one of the preceding claims, wherein the auxiliary movable element is operatively associated with a delay-action device.

18. Apparatus as claimed in any one of the preceding claims, wherein the auxiliary movable element serves, upon excitation of the machine, to operate switching means which thereupon decrease the current flowing in the windings energizing the magnetic circuit that influences the said auxiliary element.

19. Apparatus substantially as herein described, or as shown in the accompanying drawings.

Dated this 12th day of April, 1934.

REDDIE & GROSE,
Agents for the Applicant,
6, Bream's Buildings, London, E.C. 4.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1934

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1

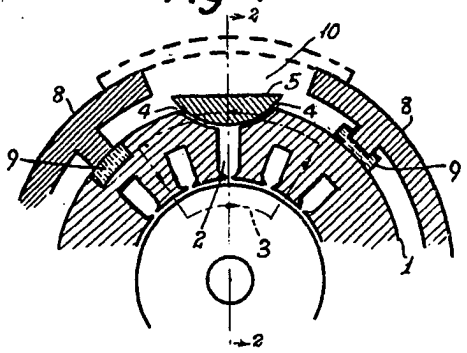


Fig. 3

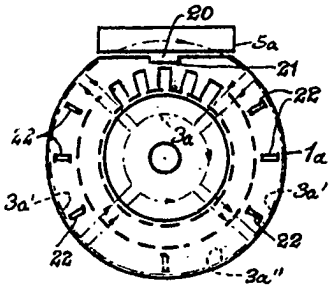


Fig. 2

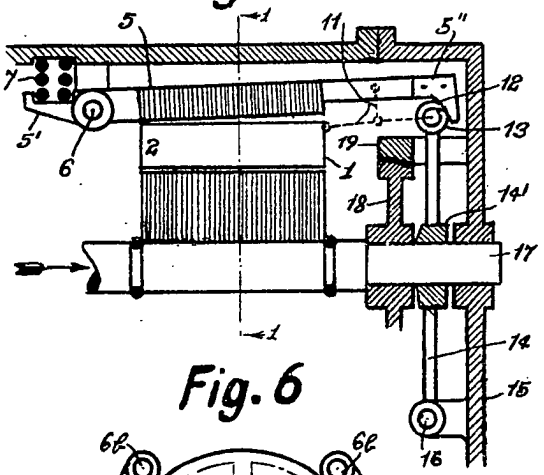


Fig. 4

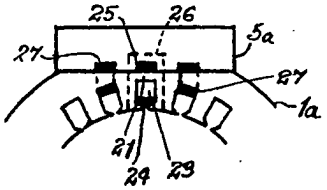


Fig. 6

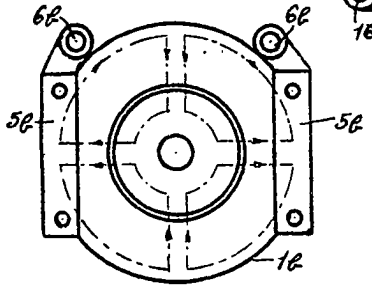


Fig. 5

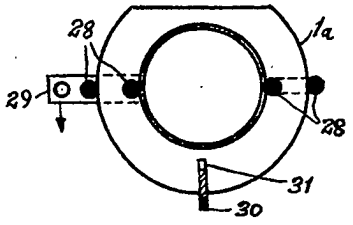


Fig. 7

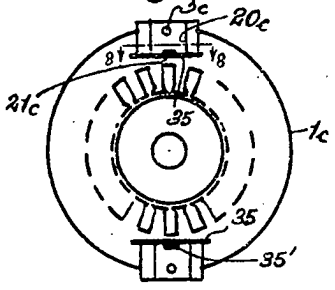
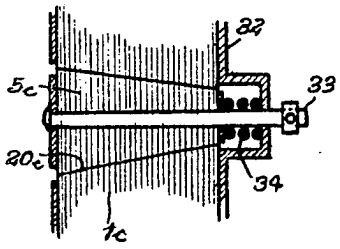


Fig. 8



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